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PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Upward Flow Fluid Filter

I, VICTOR JOHN GEORGE HARDING, a British subject of 3, Gordon Street, Paddington, New South Wales, Australia, do hereby declare the invention for which I pray that a Patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to upward flow fluid filters of the kind in which raw fluid to be filtered is passed through a particulate filtering medium, that is to say, a charge of discrete particles of suitable size and specific gravity having regard to the nature of the raw fluid.

Most filters of the kind under discussion are of the so-called down-flow type wherein the raw fluid is delivered to the top surface of a bed of the filtering medium and flows downwardly through the bed to be drained therefrom as a filtered product.

The dirt filtered out is retained partly in the filter bed and partly on top of the bed as a so-called filter cake.

Accumulated dirt eventually partially chokes the filter bed whereupon it becomes necessary to remove the dirt, and this is conventionally done by washing the bed. Washing is effected by cutting off influent raw fluid and closing the clean fluid outlet. Some of the clean fluid previously obtained is then fed to the filter below the filter bed under sufficient pressure to cause it to flow upwards through the bed in such amounts as will cause the bed to expand upwardly into a fluidised state. The clean fluid flowing through the fluidised bed liberates the trapped dirt and causes it and the overlying filter cake to be carried away to waste. The washing process is continued until the bed is clean enough to permit resumption of the filtering process, whereupon, the washing fluid is cut off, the outlet for clean fluid is re-opened and raw fluid is once again fed to the top of the filter bed.

Washing as described above must be carried out with care. If the flow rate of washing fluid is too high at the outset, the overlying filter cake may be broken up into lumps by the expanding bed of fluid particles and some of the cake — which is frequently of higher specific gravity than the fluidised bed — may sink to the bottom of the bed. In such instances, the pieces of cake cannot be recovered except by costly mechanical means and if not recovered they can subsequently erode into the out-flowing clean fluid and thereby contaminate it. During the washing process the particles of filtering medium which are usually of sensibly uniform specific gravity become hydraulically classified, that is to say, the smaller particles move to the top of the bed and the larger ones to the bottom with gradation of particle size from top to bottom. When the flow of washing fluid is cut-off the bed sinks back to a compacted condition and the particle size gradation is substantially retained. Thus, when filtering is recommenced the incoming raw fluid first meets the finely-grained top layers of the bed which rapidly become choked.

Coarse particles of incoming dirt then build up on the top of the bed to form the filter cake and, thus, the filtration rate rapidly falls so that washing is again required before the lower parts of the filter bed have accumulated an appreciable quantity of dirt.

It will be apparent that a bed of hydraulically classified particles, as described above, would operate more efficiently for a longer period if the raw fluid is passed upwardly through the bed so that the entire void capacity of the bed to contain the dirt is utilised before washing becomes necessary. However, simple upflow filters are not economically practicable because the rate of flow must be restricted to a low value as otherwise the filter bed becomes fluidised and ceases to function as a filter.

Various expedients have been used to prevent fluidisation of the bed to permit upflow

SEE ERRATA SLIP ATTACHED

filtration, for example, use has been made of an overlying layer of coarser particles of lesser specific gravity than the bed particles. For example, an overlying layer of anthracite coal particles on a bed of sand. More recently, use has been made in liquid filters of a grid of parallel bars lying in the top surface of a sand filter bed of such size and spacing that the fine grains of the filter bed collect between them and form small "sand arches" which resist the upward pressure of the bed and permit relatively high outputs per unit area of the bed. In this type of filter washing is effected by admitting compressed air with the incoming washing liquid which has the effect of breaking up the sand arches and allows the bed to rise through the grid for normal washing in the expanded fluidised state. Although the prior known filter now being described is relatively efficient in operation it has the disadvantage that the operator has to provide and maintain a source of compressed air.

With the foregoing in mind, the present invention was devised to provide an efficient upflow filter which is able to be washed in a manner retaining the desirable hydraulic classification of the particles of filtering medium.

The invention consists in an upward flow fluid filter comprising a container, a fluid pervious filter medium retainer screen disposed within said container as a partition defining the top of a medium housing chamber within said container, a charge of particulate filtering medium within said chamber of predetermined depth when in a quiescent condition, a valve controlled raw fluid and wash fluid inlet or inlets for delivery to said chamber at a position at or near the bottom thereof, a valve controlled wash fluid outlet opening into said chamber at a point below the top of the chamber by a distance from the chamber bottom at least equal to one and a half times said depth and a clean fluid outlet for the discharge of clean fluid from above said retainer screen.

Filters in accordance with the above described invention may be operated as follows: during normal filtering operation the raw fluid is provided at such a pressure and rate as to lift the bed and hold it in a compacted condition against the underside of the retainer screen, but when washing is called for the supply of raw fluid is cut-off to allow the bed to fall and disintegrate, whereupon, it may be washed in the ordinary manner with the waste fluid being discharged through the waste fluid outlet.

By way of example, two embodiments of the invention together with their operation are described hereinafter with reference to the accompanying drawings.

FIGURE 1 is a cross-sectional diagrammatic view of a fluid filter according to the invention shown as it appears during a washing operation.

FIGURE 2 is a view similar to FIGURE 1 of the same filter shown as it appears during a filtering operation.

FIGURE 3 is a view similar to FIGURE 1 of another embodiment of the invention illustrated as it appears during a filtering operation.

The filter illustrated by FIGURES 1 and 2 comprises a container 1 provided with a valve controlled raw fluid inlet R and valve controlled washing fluid inlet W, a valve controlled clean fluid outlet F and a valve controlled waste fluid outlet W^1.

A charge of particulate filter medium is disposed in a medium housing chamber within the container 1, being that space within the container above a lower support screen 3 and below an upper retainer screen 2. That charge is variously identified with reference letters A, B and C depending upon its physical condition at the time-being.

The term "screen" as used herein is intended to embrace any porous or foraminous barrier through which the particles of the filter bed cannot pass but which allows the fluid to be filtered to pass freely through it. Such screens are well-known in the art and may consist, for example, of woven fabric or metal cloths, sintered porous solids, layers of fibres randomly disposed, or in the case of lower screen 3 of a bed of particles of appropriate size and specific gravity.

As can be seen in FIGURE 1, during washing a column of fluidised particles A is maintained in a fluidised condition by an up-flowing washing fluid entering by way of the washing fluid inlet W, passing up through the support screen 3, thence through the particles A and out through a waste control valve 4 and waste outlet W^1.

In practice the column of particles A is approximately 1½ times the height H, also shown in FIGURES 1 and 2, of the quiescent bed of particles, that is to say, the bed of particles which would form on the support screen 3 under the action of gravity if all fluid flow were halted.

On completion of the washing fluid inlet W and the valve 4 may be closed and then the raw fluid inlet and clean fluid outlets R and F respectively may be opened. Raw fluid may then be passed into the space below the support screen 3 at a sufficient flow rate and pressure to cause the bed of particles to be lifted until it meets the retainer screen 2 whereupon the particles compact rapidly downwardly until a stage is reached where the upward fluid velocity is so reduced by the resistance of the suspended compacted bed that no more particles are lifted and compacted into it and the bed has a column height D; the surplus particles remain in a fluidised state in a column extending down to the lower support screen

3. This situation is illustrated in FIGURE 2 wherein the suspended operating bed is referenced B, the surplus particles are referenced C and it will be seen that there is a zone relatively free of particles therebetween.

As the filter bed B accumulates dirt the rate of flow will decrease (assuming there is a constant raw fluid supply pressure) and the fluidised column of particles C will gradually decrease in height; indeed the height of the fluidised column C gives a fairly accurate indication of the rate of flow at any particular time and gives a good indication of the need for washing. In automatically operated filters according to the invention an optical or other sensor responsive to the height of the column of particle C may be used to control the frequency of washing.

The fact that the filter bed is positively restrained in the upward direction enables the use of comparatively high pressure of influent raw fluid. For example, if water is being filtered and the filter medium is sand a pressure of around 20 lb/sq.in. may be used to provide an initial filtration rate of from 12 gallons/sq.ft/min to 28 gallons/sq.ft/min of filter bed cross-sectional area, depending on the sizing of the sand particles.

When the influent supply is cut off, the suspended bed loses its supporting force, and begins to disintegrate, from the bottom upwards, at first slowly, then with increasing rapidity until the remaining part collapses and falls with great turbulence, leaving behind it a large part of the contained dirt. If supply pressure is then restored the whole filter bed rises again and acts as a piston to expel the dirty fluid. Dropping the bed again will cause a further amount of the contained dirt to be left behind, and in the case of water it has been found that 8 to 10 cycles suffice to clean a sand bed sufficiently for the next run. This method of up-and-down cycling may therefore be used for washing. Alternatively, after first dropping the bed, washing fluid may be supplied at such rate as will expand the bed up to the efficient maximum of about 1½ times its quiescent depth (as shown in FIGURE 1) and this rate continued until the bed is clean enough for the next run, exactly as is done in normal filtration practice with the conventional down-flow type of filter.

FIGURE 3 illustrates an alternative form of the invention in which the lower support screen is dispensed, with, and the raw fluid and washing fluid are led down to near the floor of the containing vessel. In actual practice suitable means would be provided to equalise the up-flow velocity over the whole area of the up-flowing fluid.

This form results in a lesser overall height of the containing vessel by comparison with similar capacity filters according to FIGURES 1 and 2.

In experiments leading to the present invention a pilot model was constructed consisting of a 6" diameter tube, 5 ft. high, with 80 mesh B.S. screens at upper and lower positions. With a quiescent sand column about 40" high, and about 20 lb/sq.in. supply pressure of a raw water influent, a filter bed thickness of around 24" was consistently obtained, with output results that have been previously mentioned.

If filtration is continued until the filter bed becomes heavily clogged with dirt, the bed tends to remain suspended even after the influent water is cut off. This is due to a cementing action by the dirt particles, combining with the operating pressure to cause arching action of the bed between the containing walls of the small diameter filter. Some such arching action with a clogged bed could be expected in filter beds whose wall distances are less than, or only slightly more than, the depth of the filter bed. Therefore, when utilising containers in which arching is likely to occur, this arching tendency may be overcome by providing one or more fluid nozzles within the bed, or at a point or points around the periphery of the container, adapted to direct jets of fluid into the bed, thereby destroying any arched structures in the bed and initiating the disintegration of the latter before the washing begins. The fluid jets may be allowed to continue in action during the washing in order to create greater turbulence of the particles for more rapid cleaning, or the jets may be so proportioned in volume as to supply the whole of the washing fluid, in which case only the raw fluid would be led down to the floor of the containing vessel in the manner indicated in FIGURE 3.

In making use of one or more jets of fluid for the purpose of destroying any arch structures present in a clogged bed it will, of course, be necessary to provide an outlet for fluid thus injected, since the effluent outlet will be closed in preparation for the washing, and the valve 4 will also be closed, as well as the influent supply valve at R, and the main washing fluid valve at W will not yet be open.

An auxiliary controllable outlet for this purpose may be arranged below the lower screen as indicated at 5 in FIGURES 1 and 2, or at 6 in FIGURE 3. In the latter case the opening into the containing wall will be provided with a suitable screen in order to prevent escape of any bed particles.

It is to be particularly noted that the use of high pressure is not an essential feature of the working of this invention.

Once the bed is formed, the pressure may be reduced to 1½ or 2 lb/sq.in. (depending on the particle sizing of the bed) and filtration continued at that pressure if desired, or at any desired higher pressure.

It will be apparent to those versed in the art that in use the present invention is not restricted to the filtration of liquid substances

such as water, petrol, beverages, industrial solutions and the like, but is also applicable to the filtration of gaseous fluids such as air, so long as the discrete particles forming the bed are of such specific gravity and sizing that they can be fluidised in the up-flowing current of gaseous fluid and thereafter be compacted against the upper retainer screen to form a filter bed of suitable thickness, and always providing that the influent gaseous fluid does not contain sticky residues which would cement the bed particles together and thereby prevent them from disintegrating and falling down for the purpose of cleaning. For example, dust particles in dry air or a dry gas can be filtered by a bed of suitably sized particles of sawdust, light plastic or the like.

Where particularly rapid cleaning of the filter bed is required, use may be made of sonic or ultrasonic vibrations introduced into the fluidised bed particles by means of a suitable transducer or transducers arranged internally in the fluidised column or located in one or more of the containing walls. Such transducer(s) may be of the type well-known in the art of cleaning articles by immersion in a fluid in which sonic or ultrasonic vibrations are created.

Alternatively, one or more jets of the washing fluid or a compressed gaseous fluid such as air may be arranged to create high turbulence of the fluidised column during the washing phase.

In order to prevent any contamination of the upper retainer screen by dirty washing fluid during the washing process flushing means may be provided which cause an auxiliary supply of clean fluid to pass downwards through the retainer screen during the said washing process.

It will be appreciated that the terms "chamber" and "container" are to be construed broadly herein. In the drawings herewith a container is shown as a closed container with the various fluid inlets and outlets as valve controlled pipes, but in large scale filters according to the invention, such as may be used for the filtration of a City water Supply or the like, each container may be in the nature of an open-topped reservoir from which the filtered water flows by way of a weir spillway or the like, and each filter medium housing chamber may be constituted by the lower portion of said reservoir below a retainer screen therein.

WHAT I CLAIM IS:—

1. An upward flow fluid filter comprising a container, a fluid pervious, filter medium retainer screen disposed within said container as a partition defining the top of a medium housing chamber within said container, a charge of particulate filtering medium within said chamber of predetermined depth when in a quiescent condition, a valve controlled raw fluid and wash fluid inlet or inlets for delivery to fluid and wash fluid or inlets for delivery to said chamber at a position at or near the bottom thereof, a valve controlled wash fluid outlet opening into said chamber at a point below the top of the chamber by a distance from the chamber bottom at least equal to one and a half times said depth and a clean fluid outlet for the discharge of clean fluid above said retainer screen.

2. A filter according to claim 1 including a fluid pervious, filter medium supporting screen disposed within said container as a partition and constituting the floor of said chamber.

3. A filter according to claim 2 wherein said raw fluid inlet opens into said container below said supporting screen.

4. A filter according to claim 4 insofar as it depends on Claim 3 or Claim 2 wherein said washing fluid inlet opens into said container below said supporting screen.

5. A filter according to any one of the preceding claims including at least one fluid nozzle adapted to direct a jet of fluid into said chamber for breaking up or agitating said filter medium.

6. A filter according to Claim 6 having an auxiliary fluid outlet for the removal of fluid injected by said nozzle.

7. A filter according to any one of the preceding claims wherein at least one of said screens comprises a woven fabric or metal cloth, a sintered porous solid body, or a bed of particles.

8. A filter according to any one of the preceding claims including means for inducing sonic or ultrasonic vibrations in the contents of said container.

9. A filter according to any one of the preceding claims including flushing means adapted to feed an auxiliary supply of clean fluid downwardly through the retainer screen while washing is in progress.

10. A liquid filter substantially as described herein with reference to FIGURE 1 and 2 or FIGURE 3 of the accompanying drawings.

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1190248 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

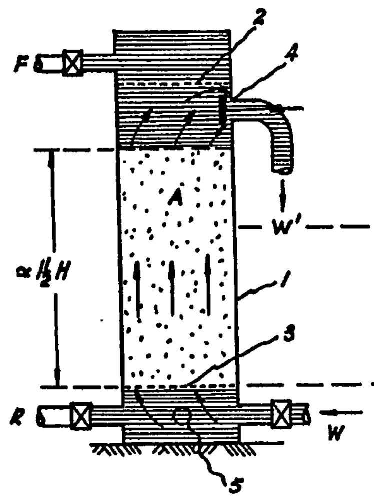

Fig. 1.

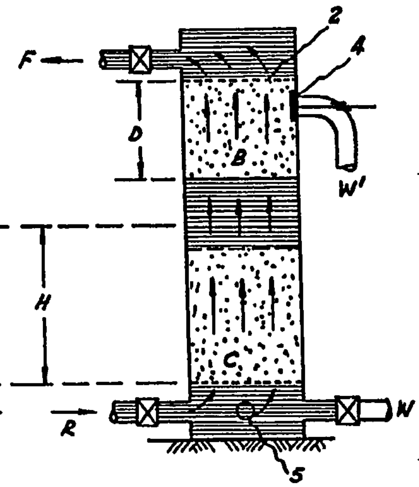

Fig. 2.

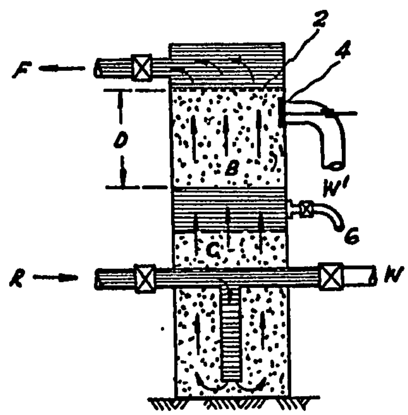

Fig. 3.